

FORM PTO-1390  
(REV 10-2000)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

TRANSMITTAL LETTER TO THE UNITED STATES  
DESIGNATED/ELECTED OFFICE (DO/EO/US)  
CONCERNING A FILING UNDER 35 U.S.C. 371

CU-2533 RJS

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

09/831532

INTERNATIONAL APPLICATION NO.  
PCT/AU99/01001INTERNATIONAL FILING DATE  
12 November 1999PRIORITY DATE CLAIMED  
12 November 1998TITLE OF INVENTION  
DIODE ARRAY SIDE-PUMPING OF A LASER SYSTEMAPPLICANT(S) FOR DO/EO/US  
John CANNING

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. ☒ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
  - a. ☒ is attached hereto (required only if not communicated by the International Bureau).
  - b. ☐ has been communicated by the International Bureau.
  - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
  - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
  - b. ☐ have been communicated by the International Bureau.
  - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
  - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

## Items 11 to 16 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☐ A **FIRST** preliminary amendment.  
☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☐ Other items or information:

Express Mail Label No.:  
EL698180950US

09/831532

17. ☒ The following fees are submitted:**BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :**

Neither international preliminary examination fee (37 CFR 1.482)  
nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO  
and International Search Report not prepared by the EPO or JPO ..... \$1000.00

International preliminary examination fee (37 CFR 1.482) not paid to  
USPTO but International Search Report prepared by the EPO or JPO ..... \$860.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but  
international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... \$710.00

International preliminary examination fee paid to USPTO (37 CFR 1.482)  
but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... \$690.00

International preliminary examination fee paid to USPTO (37 CFR 1.482)  
and all claims satisfied provisions of PCT Article 33(1)-(4) ..... \$100.00

**ENTER APPROPRIATE BASIC FEE AMOUNT =****CALCULATIONS** PTO USE ONLY

\$ 1000.00

Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30  
months from the earliest claimed priority date (37 CFR 1.492(e)).

\$

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE
Total claims	- 20 =		X \$18.00
Independent claims	- 3 =		X \$80.00

\$

\$

MULTIPLE DEPENDENT CLAIM(S) (if applicable)

+ \$270.00

\$

**TOTAL OF ABOVE CALCULATIONS =**

\$ 1000.00

☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above  
are reduced by 1/2.

\$

**SUBTOTAL =**

\$ 1000.00

Processing fee of \$130.00 for furnishing the English translation later than ☐ 20 ☐ 30  
months from the earliest claimed priority date (37 CFR 1.492(f)).

\$

+

**TOTAL NATIONAL FEE =**

\$

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be  
accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property

\$

+

**TOTAL FEES ENCLOSED =**

\$ 1000.00

Amount to be  
refunded:

\$

charged:

\$

a. ☒ A check in the amount of \$ 1000.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. \_\_\_\_\_ in the amount of \$ \_\_\_\_\_ to cover the above fees.  
A duplicate copy of this sheet is enclosed.

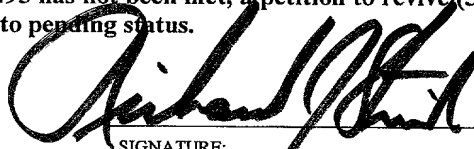
c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any  
overpayment to Deposit Account No. 12-0400. A duplicate copy of this sheet is enclosed.

**NOTE:** Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR  
1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Ladas & Parry  
224 South Michigan Avenue  
Suite 1200  
Chicago, Illinois 60604  
(312) 427-1300

May 10, 2001



SIGNATURE:

Richard J. Streit

NAME

25765

REGISTRATION NUMBER

# DIODE ARRAY SIDE-PUMPING OF A LASER SYSTEM

## Field of the Invention

The present invention relates to diode pumped laser systems.

## 5 Background of the Invention

Diode pumped solid-state crystal lasers are becoming increasingly popular due to their compact nature and high output power characteristics.

However, for optical signal processing applications it is desirable to utilise pumped waveguides to produce a laser output rather than solid-state crystal lasers, which are more difficult to incorporate into e.g. optical integrated circuits.

Suitable waveguides include e.g. doped cores of  
15 optical fibres or doped planar waveguide structures.

Such waveguides, i.e. those which are capable of producing a laser output upon pumping with a pump energy, presently require an efficient coupling of the pump energy light signal into e.g. the doped core of the optical fibre via the fibre cladding.

To minimise coupling losses various coupling techniques have been suggested, however, it is a common feature that they do require additional components/structures which need to be integrated into e.g. the optical integrated circuit, thereby resulting in more complex and less compact designs.

Furthermore, typically individual sources of the pump energy light signals are required for each waveguide to be pumped, the sources being individually coupled to the respective waveguides.

## Summary of the Invention

In accordance with the present invention, there is provided a laser system comprising: at least one array of closely spaced diodes arranged to emit radiant pump energy, and a plurality of waveguides spaced adjacent the array, each waveguide being arranged to lase upon exposure to the radiant pump energy emitted from the diodes.

[illegible]

- 2 -

A single diode array is thus utilised as a single source for the pumping of multiple waveguides at one time, without a requirement for individual coupling means.

The waveguides may be arranged to lase at  
 5 different frequencies. This can e.g. be utilised for provision of multiplexed optical signals.

The system can further include a coupler for coupling laser outputs of individual waveguides to form a combined laser output.

10 The system may further comprise reflection means spaced closely adjacent the waveguides and the array for reflecting the radiant pump energy emitted from the array back onto the waveguides.

The plurality of waveguides can comprise a series  
 15 of optical fibres or of planar waveguides.

The waveguides may form a multi-mode interference device.

The waveguides can be formed as part of a multimode waveguide structure which can be interconnected  
 20 to a single mode waveguide.

#### Brief Description of the Drawings

Notwithstanding any other forms which may fall within the scope of the present invention, preferred forms of the invention will now be described, by way of example  
 25 only, with reference to the accompanying drawings in which:

Fig. 1 illustrated a first example embodiment of the present invention;

Fig. 2 illustrates a second example embodiment of the present invention;

30 Fig. 3 illustrates a third example embodiment;

Fig. 4 illustrates a fourth example embodiment;

Fig. 5 illustrates utilisation of the principle of the present invention in a multi-mode interference device; and

35 Fig. 6 illustrates a further embodiment of the present invention

#### Description of Preferred and Other Embodiments

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- 3 -

In Fig. 1, there is illustrated a first example embodiment 1 of the present invention. In this embodiment, a series or bundle waveguides in the form of distributed feedback (DFB) fibre lasers 2, which can include tuned  
5 Bragg grating structures to provide for particular frequency characteristics, are pumped by a diode bar 3. In the example, 32 DFB lasers are assumed to be provided. Of course, alternative arrangements are possible for example, the fibres could be more spaced apart and form a single  
10 layer on the diode bar. Obviously, many different slacking arrangements are possible. The diode bar 3 acts as a high intensity pump which causes the DFB lasers to lase. The fibres are attached together by a 32 to 1 splitter 6 so as to provide output 7 having multiple combined frequency  
15 channels.

The principles of Fig. 1 can be extended to other waveguide systems. For example, in Fig. 2, there is illustrated a waveguide system wherein a diode bar 10 is placed upon a waveguide 11 on which a series of DFB lasers  
20 12 are formed in the core. The diode bar 10 is utilised to pump the DFB lasers 12 to provide for outputs 13.

Other arrangements are possible as illustrated in Fig. 3 wherein a waveguide 20 is provided on a substrate 21 and a diode bar 22 is provided for pumping the waveguide  
25 20. The diode bar 22 is inclined with respect to the substrate 21 so that pumping wavelength energy is reflected by the substrate 21 and in turn by a reflector 24 so as to provide for enhanced operational characteristics. The pumping causes the waveguide 20 to lase so as to produce  
30 output 25.

In Fig. 4, there is illustrated an alternative arrangement where the diode bar 30 is placed at one end of the substrate 31 which includes a series of DFB waveguides 32 placed therein. The diode bar 30 is utilised to cause  
35 the DFB lasers to lase 32 so as to produce output 33.

The arrangements of Fig. 1 - 4 provide for an inexpensive form of arrangement of diode pumping of

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multiple waveguides simultaneously. This has significant advantage when constructing laser devices or other large area pumping of active waveguides. An example of its application is in the field of multi-mode interference devices. These devices can be, as illustrated in Fig. 5, formed on a waveguide 40 and include a series of active waveguides 41 between two couplers 42, 43. The diode bar 44 can be placed over the active portions so as to provide for large area pumping of the active waveguide portions 41 and therefore provide for different output couplings from input 46 to output 47 in accordance with requirements.

Turning now to Fig. 6, there is illustrated a further embodiment where a large power coupling is required for high power applications. A diode bar 50 is utilised to pump a large area multi-mode waveguide 51 which in turn is tapered into a single mode waveguide 52 so as to provide for high output power 53 pump wavelength which in turn can be utilised to pump other devices.

It would be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

In the claims that follow and in the summary of the invention, except where the context requires otherwise due to express language or necessary implication, the word "comprising" is used in the sense of "including", i.e. the features specified may be associated with further features in various embodiments of the invention.

We Claim:

1. A laser system comprising:
  - at least one array of closely spaced diodes arranged to emit radiant pump energy; and
  - 5       - a plurality of waveguides spaced adjacent the array, each waveguide being arranged to lase upon exposure to the radiant pump energy emitted from the diodes.
2. A laser system as claimed in claim 1, wherein the waveguides are arranged to lase at different
- 10       frequencies.
3. A laser system as claimed in any one of the preceding claims, wherein the system further comprises a coupler for coupling laser outputs of individual ones of the waveguides to form a combined laser output.
- 15       4. A laser system as claimed in any one of the preceding claims, wherein the system further comprises reflection means spaced closely adjacent the waveguides and the array for reflecting the radiant pump energy emitted from the array back onto the waveguides.
- 20       5. A laser system as claimed in any one of the preceding claims, wherein the plurality of waveguides comprise a series of optical fibres.
6. A laser system as claimed in any one of the preceding claims, wherein the plurality of waveguides
- 25       comprises a series of planar waveguides.
7. A laser system as claimed in any one of the preceding claims, wherein the waveguides form a multi-mode interference device.
8. A laser system as claimed in any one of the preceding claims, wherein the waveguides are be formed as
- 30       part of a multimode waveguide structure which can be interconnected to a single mode waveguide.

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TOT080"265T E860

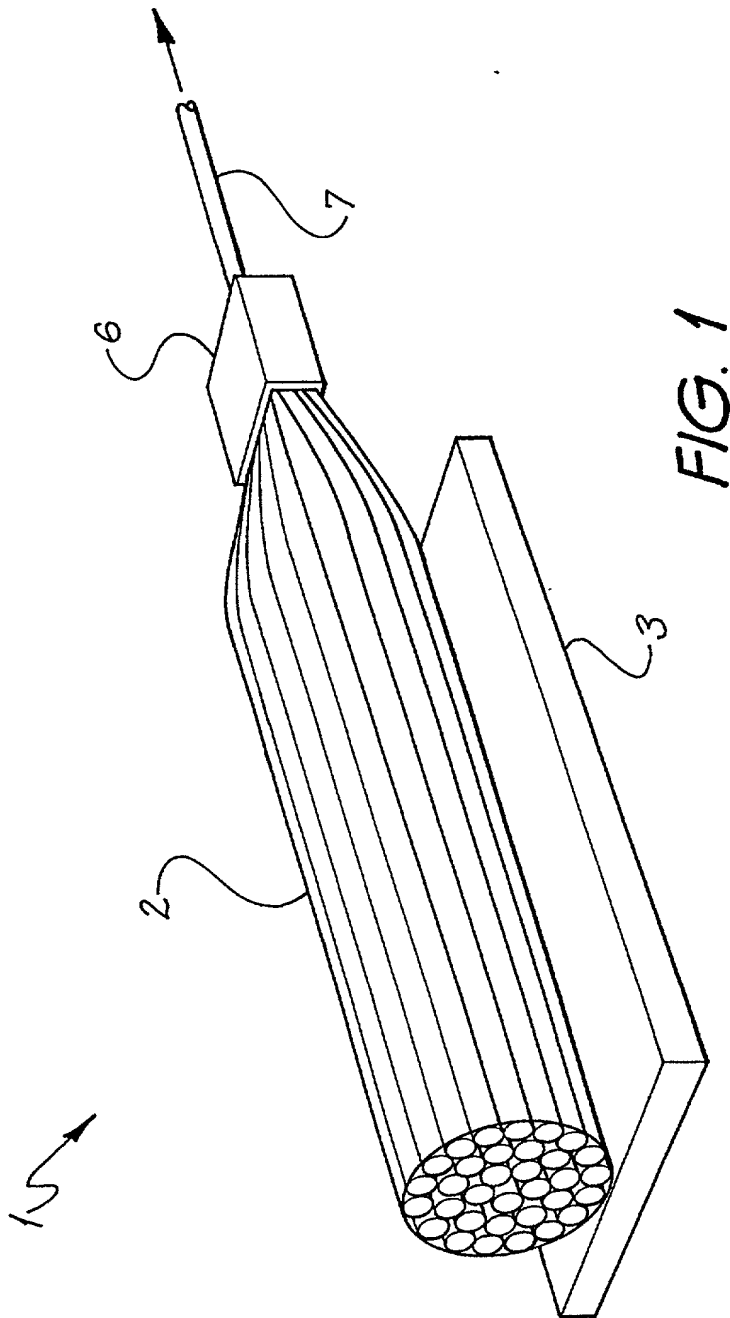


FIG. 1



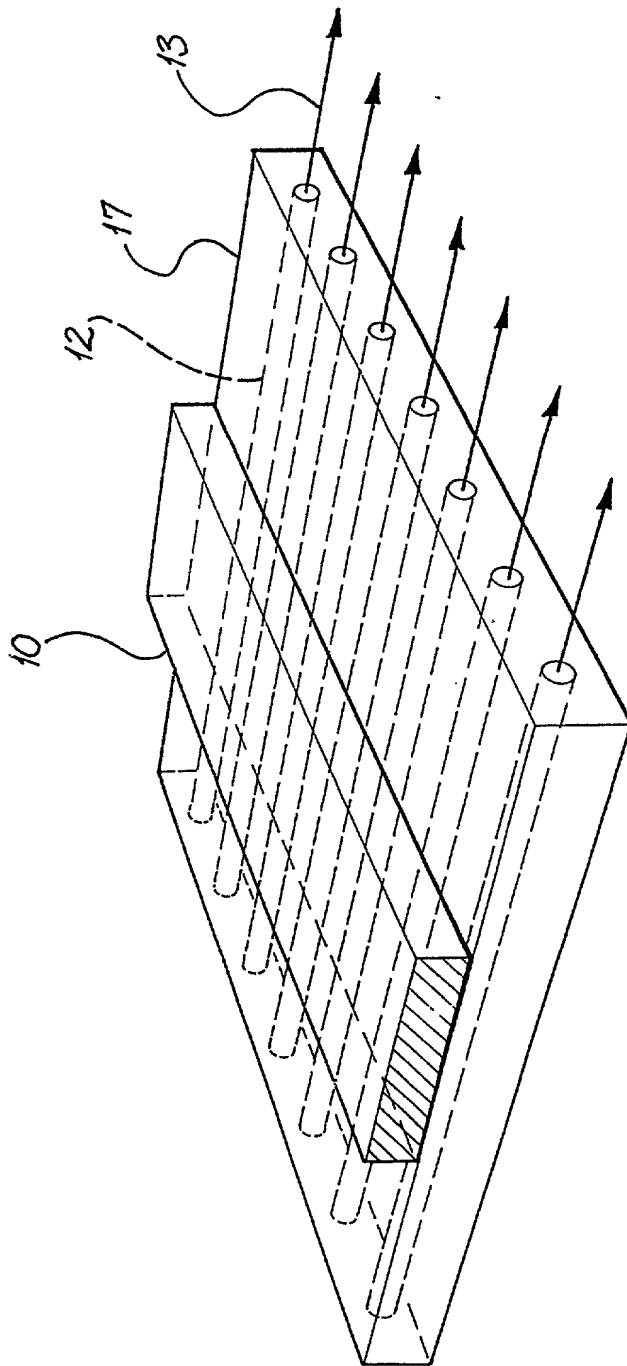
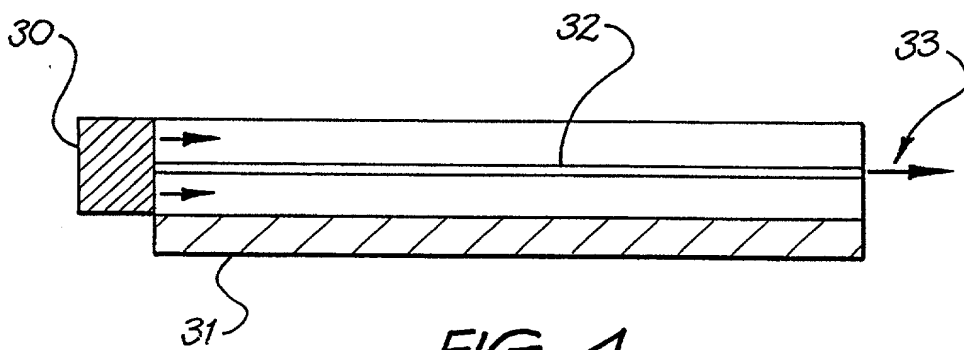
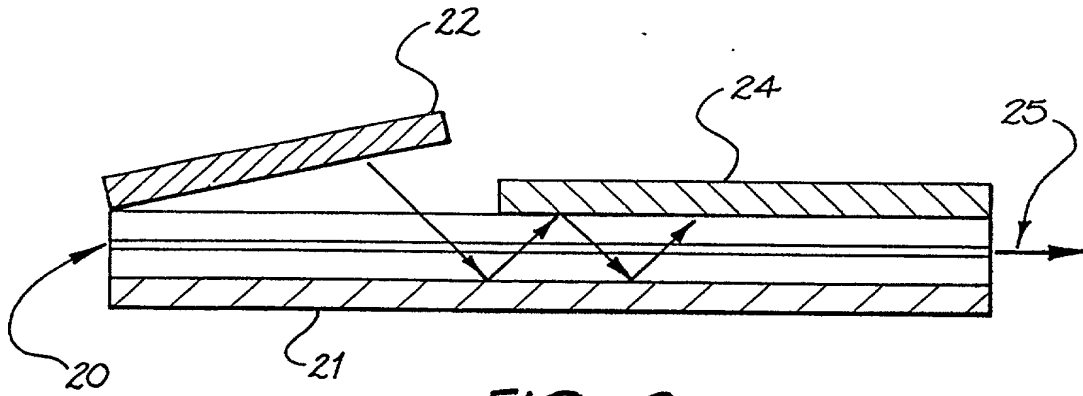


FIG. 2



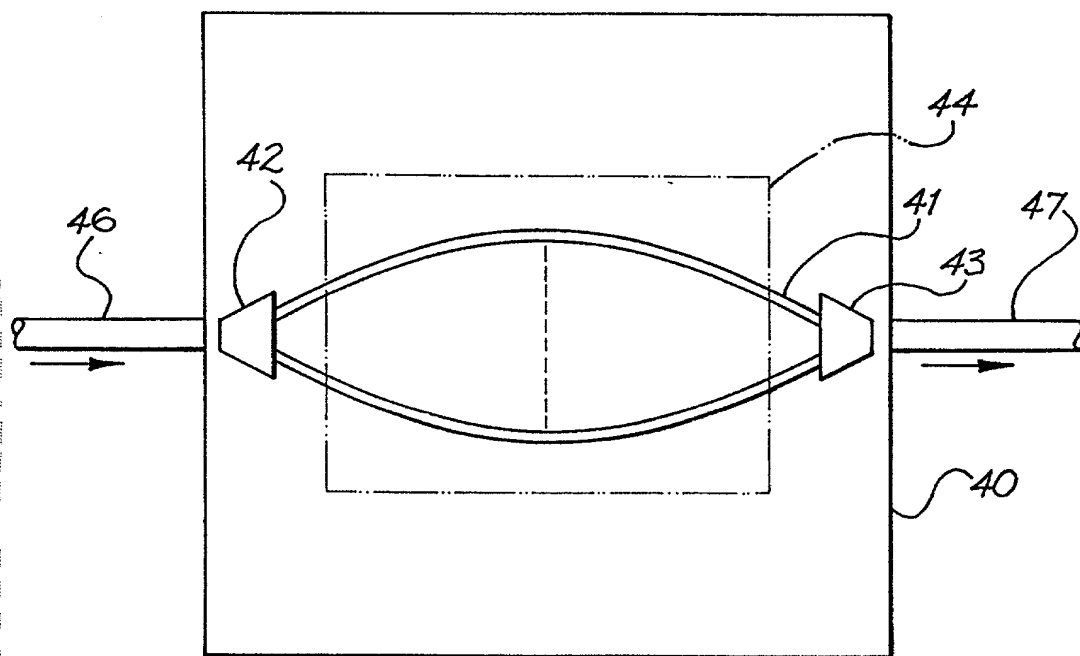


FIG. 5

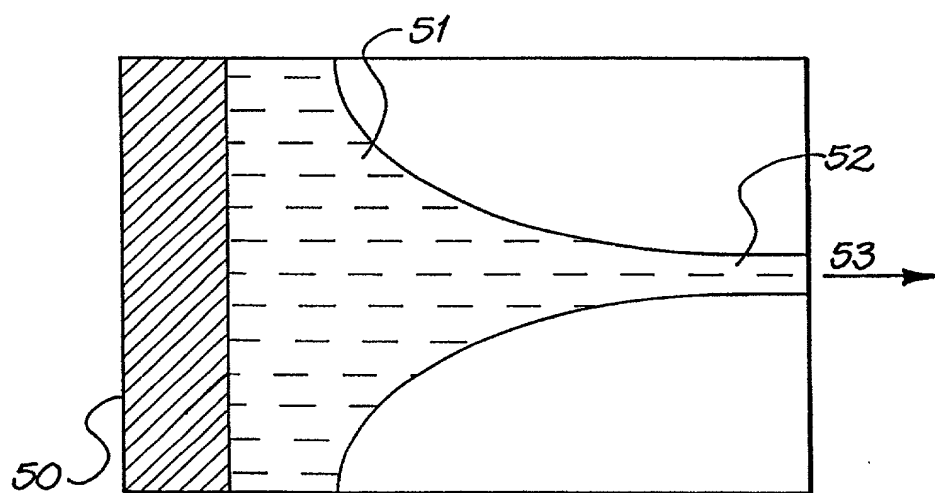


FIG. 6

Docket: CU-2533

PATENT

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**COMBINED DECLARATION AND POWER OF ATTORNEY**

(ORIGINAL, DESIGN, NATIONAL STAGE OF PCT, SUPPLEMENTAL, DIVISIONAL,  
CONTINUATION OR CIP)

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As a below named inventor, I hereby declare that:

**TYPE OF DECLARATION**

This declaration is of the following type: (check one applicable item below)

- ☐ original  
☐ design  
☐ supplemental

Note: If the Declaration is for an International Application being filed as a divisional, continuation or continuation-in-part application, do not check next item; check appropriate one of last three items.

- ☒ national stage of PCT

Note: If one of the following 3 items apply, then complete and also attach ADDED PAGES FOR DIVISIONAL, CONTINUATION OR CIP.

- ☐ divisional  
☐ continuation  
☐ continuation-in-part (CIP)

**INVENTORSHIP IDENTIFICATION**

WARNING: If the inventors are each not the inventors of all the claims, an explanation of the facts, including the ownership of all the claims at the time the last claimed invention was made, should be submitted.

My residence, post office address and citizenship are as stated below, next to my name. I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter that is claimed, and for which a patent is sought on the invention entitled:

**TITLE OF INVENTION**

DIODE ARRAY SIDE-PUMPING OF A LASER SYSTEM

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**SPECIFICATION IDENTIFICATION**

the specification of which: *(complete (a), (b) or (c))*

☐ (a) is attached hereto.

☐ (b) was filed on \_\_\_\_\_ as ☐ Serial No. \_\_\_\_\_ or ☐  
Express Mail No. *(as Serial No. not yet known)* \_\_\_\_\_ and was amended  
on \_\_\_\_\_  
\_\_\_\_\_ *(if applicable)*.

*Note: Amendments filed after the original papers are deposited with the PTO that contain new matter are not accorded a filing date by being referred to in the Declaration. Accordingly, the amendments involved are those filed with the application papers or, in the case of a supplemental Declaration, are those amendments claiming matter not encompassed in the original statement of invention or claims. See 37 CFR 1.67.*

☒ (c) was described and claimed in PCT International Application No. PCT/AU99/01001 filed on 12 November 1999.

**ACKNOWLEDGEMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR**

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information, which is material to patentability as defined in 37, Code of Federal Regulations, § 1.56,

*(also check the following items, if desired)*

☐ and which is material to the examination of this application, namely, information where there is a substantial likelihood that a reasonable Examiner would consider it important in deciding whether to allow the application to issue as a patent, and

☐ in compliance with this duty, there is attached an information disclosure statement, in accordance with 37 CFR 1.98.

**PRIORITY CLAIM (35 U.S.C. § 119(a)-(d))**

I hereby claim foreign priority benefits under Title 35, United States Code, § 119(a)-(d) of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

(complete (d) or (e))

☐ (d) no such applications have been filed.☒ (e) such applications have been filed as follows.

*Note: Where item (c) is entered above and the international application which designated the U.S. itself claimed priority check item (e), enter the details below and make the priority claim.*

**PRIOR FOREIGN/PCT APPLICATION(S) FILED WITHIN 12 MONTHS  
(6 MONTHS FOR DESIGN) PRIOR TO THIS APPLICATION  
AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119(a)-(d)**

COUNTRY (OR INDICATE IF PCT)	APPLICATION NUMBER	DATE OF FILING (day/month/year)	PRIORITY CLAIMED UNDER 35 USC 119
Australia	PP 7170	12 November 1998	<input checked="" type="checkbox"/> YES    NO <input type="checkbox"/>
			<input type="checkbox"/> YES    NO <input type="checkbox"/>

**CLAIM FOR BENEFIT OF PRIOR U.S. PROVISIONAL APPLICATION(S)  
(35 U.S.C. § 119(e))**

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below:

PROVISIONAL APPLICATION NUMBER	FILING DATE

**ALL FOREIGN APPLICATION(S), IF ANY, FILED MORE THAN 12 MONTHS  
(6 MONTHS FOR DESIGN) PRIOR TO THIS U.S. APPLICATION**

*Note: If the application filed more than 12 months from the filing date of this application is a PCT filing forming the basis for this application entering the United States as (1) the national stage or (2) a continuation, divisional, or continuation-in-part, then also complete ADDED PAGES TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR DIVISIONAL, CONTINUATION OR CIP APPLICATION for benefit of the prior U.S. or PCT application(s) under 35 U.S.C. § 120.*

T01020 2657550

## POWER OF ATTORNEY

I hereby appoint the following practitioner(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (*list name and registration number*).

**Thomas F. Peterson, 24790; Richard J. Streit, 25765; Donald P. Reynolds, 26220; W. Dennis Drehkeff, 27193; Vangelis Economou, 32341; Brian W. Hameder, 45613; Paul B. West, 18947; Joseph H. Handelman, 26179; Peter D. Galloway 27885; John Richards, 31503; Iain C. Baillie, 24090; Richard P. Berg, 28145**

- ☐ Attached, as part of this declaration and power of attorney, is the authorization of the above-named practitioner(s) to accept and follow instructions from my representative(s).

## SEND CORRESPONDENCE TO:

**Thomas F. Peterson**  
**c/o Ladas & Parry**  
**224 South Michigan Avenue**  
**Suite 1200**  
**Chicago, Illinois 60604**

## DIRECT TELEPHONE CALLS TO:

(Name and telephone number)

**(312) 427-1300**

## DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

## SIGNATURE(S)

*Note: Carefully indicate the family (or last) name, as it should appear on the filing receipt and all other documents.*

**Full name of sole inventor**

John

(Given Name)

(Middle Initial or Name)

CANNING

(Family (or Last) Name)

**Inventor's signature**

**Date** 19 July 2001

**Country of Citizenship** Australia

**Residence** Carlton, NSW Australia

**Post Office Address** 10 Francis Street, Carlton, NSW 2218, Australia